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Diplomarbeit

Titel der Diplomarbeit

Ăn fluencing factors on the performance in Inequity aversion in dogs (*Canis familiaris*)ñ

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1. Abstract

Dogs have been shown to avoid unequal rewarding, that is, they refuse to obey a certain command when being unrewarded while another dog gets food for the same action. Interestingly, dog-pairs show variable performance in this task. The aim of this study was to determine what effects whether dogs show strong inequity aversion or better tolerate unequal rewarding. For this purpose, in addition to the inequity task, a questionnaire was filled in by the owner and 4 independent experiments were conducted to test the personality and social relationship of the dogs, and these results were related to the performance of the dogs in the inequity task.

22 dogs participated in the experiments. First, dogs were tested for their reaction to unequal treatment. The inequity task consisted of 6 different conditions, in 4 of them they were tested next to a partner (social conditions) and in two conditions they were tested alone (asocial conditions). The social conditions varied in reward distribution, effort and value of the food item. After the subject dogs cooperated with the experimenter by giving their paw on command, they received either a reward of the same value as their partner (equity test), a less preferable reward compared to the partner (quality inequity), no reward in contrast to the partner (reward inequity) or had to work for a reward whereas the partner received it for free (effort control). In the asocial conditions, dogs were first rewarded for their action (assessment control), but after a point they received no more reward but the experimenter pretended to give it to an imaginary partner (movement control).

In the so-called Novel task each dog was confronted with an unfamiliar problem (a manipulative toy baited with food) and their manipulation was recorded in order to measure their level of motivation. In the Attention task we investigated how much attention the dogs paid to their partner. The Co-feeding and the Favourite toy tasks aimed to test the social relationship between the dogs, specifically their dominance relations and tolerance to each other in competition over food or toys.

We found that neither rank nor sex predicted the outcome of the inequity task, and attention paid to the partner in the Attention task was also unrelated to it. Motivation of the dogs was well-reflected in the asocial inequity conditions since dogs that were

persistent in the problem-solving task worked longer for the experimenter even without being rewarded when they were alone. However, when they faced unequal reward distribution while being paired with a rewarded partner they lost their motivation and did not work longer than the dogs with low motivation. In contrast to the above factors that did not explain the variable response of dogs to unequal rewarding, we found that dogs that were more socially tolerant according to their owners and did not displace their partner were less inequity averse than the less socially tolerant ones.

2. Zusammenfassung

Bei Hunden wurde festgestellt, dass sie ungleiche Belohung vermeiden. Das heißt, sie verweigern einem Kommando zu gehorchen, wenn sie dafür keine Belohnung erhalten, während ein anderer Hund für dieselbe Aufgabe Futter erhält. Interessanterweise zeigen Hunde in ihrem Verhalten eine gewisse Variabilität. Das Ziel dieser Studie war herauszufinden, welche Faktoren Einfluss darauf haben, ob Hunde eine starke Ablehnung gegenüber ungerechter Behandlung zeigen oder eher ungleiche Belohnung tolerieren. Zu diesem Zweck wurden, zusätzlich zu der Fragestellung bezüglich Ungerechtigkeitsempfinden bei Hunden, ein Fragebogen von den Hundebesitzern ausgefüllt sowie 4 unabhängige Experimente durchgeführt, die Aufschluss über den Charakter der Hunde und deren soziale Beziehung geben sollten. Diese Resultate wurden zu den Reaktionen der Hunde in Bezug auf Ungerechtigkeit in Beziehung gesetzt.

22 Hunde nahmen an den Experimenten teil. Zuerst wurde die Reaktion der Hunde auf ungleiche Behandlung untersucht. Diese Aufgabe bestand aus 6 verschiedenen Versuchsbedingungen ï bei 4 davon wurden sie mit einem Partner gestestet (sozial) und bei 2 davon alleine (nicht-sozial). Die Versuchsbedingungen mit Partner variierten in Art der Aufteilung der Belohnung, Arbeitsaufwand und Wertigkeit der Belohnung. Nach erfolgreicher Kooperation mit dem Versuchsleiter, durch Pfote geben auf Kommando, erhielten die Hunde entweder eine gleichwertige Futterbelohnung wie ihr Partner (Test auf Gleichheit), eine weniger bevorzugte Belohnung (Test auf Qualität), keine Belohnung im Gegensatz zu ihrem Partner (Test auf ungleiche Belohnung) oder hatten für den Erhalt der Belohnung mit dem Versuchsleiter zu kooperieren, während der Partner Futter bekam, ohne dafür zu arbeiten (Test auf Arbeitsaufwand). Unter jenen Versuchsbedingungen, in denen die Hunde alleine getestet wurden, wurden die Hunde zuerst für ihre Arbeit belohnt (Bewertungsgrundlage) aber ab einem bestimmten Punkt erhielten sie keine Belohnung mehr, jedoch gab der Versuchsleiter vor, diese an einen imaginären Partner zu geben (Kontrolle auf Bewegung des Futters).

Im ersten der weiteren Experimente wurde jeder Hund mit einem unbekannten Problem konfrontiert (ein Spielzeug, das manipuliert werden konnte und in dem Futterstücke versteckt waren). Um ihre Motivation zu beurteilen, wurde das

Manipulationsverhalten aufgezeichnet. Im zweiten Experiment wurde untersucht, wie aufmerksam die Hunde ihrem Partner gegenüber waren. Die Beziehung zwischen den Hunden, vor allem in Bezug auf Dominanz und Toleranz, wurden im dritten und vierten Experiment in einer Konkurrenzsituation um Futter bzw. Spielzeug untersucht.

Wir stellten fest, dass weder Rang noch Geschlecht die Ergebnisse der Hunde in Bezug auf ihre Reaktion bei ungleicher Behandlung voraussagen konnten, wie auch die Aufmerksamkeit gegenüber dem Partner in einem der zusätzlichen Tests keinen Rückschluss zuließ. Die Motivation der Hunde wurde gut in den nicht-sozialen Konditionen reflektiert, da jene Hunde, die mehr Ausdauer beim Lösen eines unbekannten Problems zeigten, auch länger mit dem Versuchsleiter kooperierten, sogar wenn sie dafür nicht belohnt wurden. Wenn die Hunde jedoch neben einem Partner arbeiteten, der im Gegensatz zu Ihnen Futter bekam, sie also einer ungerechten Behandlung ausgesetzt waren, sank ihre Motivation und sie kooperierten nicht länger als jene Hunde, die ohnehin eine geringe Motivation zeigten. Im Gegensatz zu den genannten Faktoren, die das Verhalten der Hunde bei ungleicher Belohnung nicht erklären konnten, fanden wir, dass jene Hunde, die laut ihren Besitzern sozial toleranter sind und ihren Partner nicht von seinem Platz vertreiben, weniger Ablehnung gegenüber ungleicher Behandlung zeigten, als weniger tolerante Individuen.

3. Introduction

3.1 Inequity Aversion in Humans

Among humans, cooperation is common to achieve a goal that cannot be accomplished by one person alone. Individuals that engage in cooperative interactions may benefit from comparing their costs and gains to those of the others involved, and therefore may have developed a sense for what is a fair and what is not. Humans seem to have a well-developed sense of fairness and respond negatively to unfair treatment which may even result in punishing a non-cooperative individual (Heinrich et al., 2001; Fehr and Rockenbach, 2003; Zizzo and Oswald, 2001). For instance, an investor who provides a trustee with money in exchange for another cooperative action will fine the trustee in case of non-compliance. Fehr and Schmidt (1999) modelled fairness as a self-centered inequity aversion where people refuse inequitable outcomes providing them with lower payoff than that of others (disadvantageous inequity aversion (Fehr and Schmidt, 1999), but named also as undercompensation in social psychology; Walster et al., 1978). There can be another form of unequal distribution of goods, however, that is beneficial for an individual: if she gets the larger share in contrast to her partner. Interestingly, humans find also this kind of inequity unfair and experience negative feelings - this is the so-called advantageous inequity aversion (Fehr and Schmidt, 1999) (or overcompensation; Walster et al. 1978). Humans that posses a sense of fairness and find themselves in situations where they get less than another person may benefit from moving on to other individuals with whom they can cooperate more equally (Fehr und Schmidt, 1999). Comparing oneôs efforts and costs to those of others and reacting negatively to social inequities is therefore considered to play an essential role in the evolution of cooperation (Fehr and Schmidt, 1999).

Brosnan et al. (2004a) assumed that there are three steps that were important for the evolution of disadvantageous inequity aversion. First, it is crucial to recognize that another individual obtains more or better rewards than oneself. Second, this discrepancy should be strong enough to lead the individual to alter its behaviour. For example one would consider it fair if two individuals that cooperatively hunt together get the same share of the prey. If now one of the two repeatedly faces situations in which the other individual claims the vast majority of the prey the disadvantaged

individual, if sensitive to unequal rewarding, should stop to cooperate with this companion and try to recruit a new partner. Thus, an underbenefitted individual should abandon inequitable relationships, and as a consequence, increase its relative fitness by moving on to another partner that is more orientated towards equity.

3.2 Inequity aversion in non-human primates

Since there are plenty of animal species that engage in cooperation (Dugatkin, 1997; Stevens and Gilby, 2004) one could argue that a sense of fairness as described above is not uniquely human but exists also in animals. Accordingly, it has been suggested that animals may have expectations about what to receive compared to previous situations or compared to others (Tinklepaugh, 1928; Brosnan, 2006). Although anecdotal evidence of inequity aversion in animals is existent, experimental research under controlled conditions is needed to proof if and to determine to what extent animals are able to react to unequal treatment.

Studying monkeys and apes, our closest non-human relatives, can inform us about the origins of inequity aversion. Like in human societies, cohabitation of individuals is subject to common rules and conventions. Some non-human primates show social conventions in interspecific interactions (e.g. competition, play) (Perry et al., 2003; Perry and Manson, 2003), coordinate when engaging in cooperative hunting (e.g. Boesch, 1994; Perry and Rose, 1994), and are tolerant enough to allow food sharing and cooperation (e.g. de Waal, 2007; de Waal and Berger, 2000; Brosnan and de Waal, 2002). Thus, one can expect that monkeys and apes may be capable of evaluating the shares of their own and of others and react negatively when facing disadvantageous situations.

Brosnan and colleagues (2003, 2004) found that capuchin monkeys (*Cebus apella*) and chimpanzees (*Pan troglodytes*) are sensitive to unequal treatment. Subjects had to exchange a token to receive a food reward and were tested under different conditions varying the presence or absence of the partner, the value of the food reward and the effort needed to get the food. Results indicated that capuchins and chimps react to iniquitous situations, as subjects increased their refusals to exchange a token with the experimenter for food if they had witnessed a conspecific obtain a

piece of more preferred reward for the same action. Furthermore, observing the partner getting the more desirable food for free amplified this effect in the capuchins. No effect of effort was found in chimps, but the authors argued that this may be due to the different physical requirements the token exchange constituted for the two species (Brosnan et al., 2004).

Brosnan and colleaguesô(2003, 2004) results evoked increased interest in the topic of inequity aversion, but further research resulted in partly contradictory findings. For example, in more recent studies capuchin monkeys did not show higher refusal when tested with a partner that received better reward in contrast to themselves (Dubreuil et al., 2006; Roma et al., 2006; Fontenot et al., 2006), and chimpanzees rejected fewer food pieces when a competitor was present and given more preferable food (Bräuer et al., 2006). However, different to the initial study, none of these studies required the animals to exchange a token in order to get rewarded. It is known that animals differentiate between rewards that are given for free and rewards they have to earn (Carder and Berkowitz, 1970). This might explain why no reaction to inequity was found in studies that did not include a task. Brosnan et al. (2010) argue that individuals perceive a task that is required to earn some reward as a joint activity with their partner and subsequently expect equitable outcomes.

However, the results from Brosnan et al. were replicated with capuchins that reacted averse to inequity (Wolkenten et al., 2007). Subjects that were tested in a token exchange paradigm showed a significant drop in exchange rates in the inequity condition compared to the equity conditions and individuals to some extent showed sensitivity to their own energy expenditure.

3.3 Factors influencing inequity aversion/cooperation

Scientific research carried out on inequity aversion and cooperation also tried to determine if there are certain factors that influence the individualsô reaction in an inequity task and respectively which components facilitate successful cooperation.

From studies dealing with cooperation in non-human primates it is known that there are several factors that affect the positive outcome of a cooperation task. Exchange of information, mainly via visual cues and social monitoring, plays an important role since it makes it possible that individuals can adjust their behaviour to those of the partner (e.g. chimpanzees, Chalmeau and Gallo, 1996; e.g. orangutans, Chalmeau et al., 1997; e.g. cottontop tamarins, Cronin et al., 2005). Success rates in capuchin monkeys significantly dropped after they were prevented from visual contact to their partner (Mendres and de Waal, 2000). Furthermore, low tolerance may act as a constraint on the ability to solve a task cooperatively simply because tolerance is needed to act in close proximity (e.g. rhesus macaques, Crawford, 1937; e.g. marmosets, Werdenich and Huber, 2002; e.g. chimpanzees, Melis et al. 2006). Tolerance has been described as the lack of punishing others for stealing food, and as close proximity/physical contact, or allogrooming. Typically individuals in close relationships (e.g. relatives, parents-offspring) are more likely to show higher levels of tolerance (Clark and Grote, 2003). Melis and colleagues (2006) found that only socially tolerant pairs and parent-offspring dyads succeeded in a string-pulling task whereas socially less tolerant pairs failed.

Distribution of food rewards and food sharing have been accounted as another factor influencing the willingness to cooperate. The parent-offspring chimpanzee dyads (Melis et al., 2006) were more cooperative if the food rewards were presented in a dispersed way and could not be monopolized by one individual, and cottontop tamarins also performed best when reward payoffs were equal (Cronin and Snowdon, 2008). Positive impacts of food exchange were found in capuchins and marmosets (Mendres and de Waal, 2000; de Waal and Berger, 2000; Werdenich and Huber, 2002).

Aversive reactions to inequity can be found in a huge variety of human cultures, and reactions are dependent on the quality of the individualsô relationship (Clark and Grote, 2003). Loewenstein et al. (1989) stated that individuals in positive or neutral relationships are more orientated towards equity than individuals in negative ones, reacting averse if they get more than their partner. Clark and Grote (2003) postulated that individuals in close relationships are much more likely to posses a communal orientation (i.e. giving benefits in response to the otherôs needs) than are those in

less close relationships, who follow contingent rules like equity and equality. In animal groups, the character of the relationship between individuals and especially the relations between dominants und subordinates account for the vast majority of variation (e.g. distribution of food, mates, social partners), and, similar to humans, responses to inequity should be tempered by group dynamics (de Waal, 1991, 1996; Brosnan, 2006).

How social relationships can influence an individual's performance was shown in a study with chimpanzees (Brosnan et al., 2004) where there was a significant difference in the behaviour of animals that were pair-housed, living in short-term or long-term relationships. Pair-housed chimps and others in short-term social relationships frequently refused to exchange when the partner received a better reward. In contrast to this, individuals living in long-term relationships showed hardly any refusals in the inequity condition. This suggests that socially more tolerant individuals are also more tolerant if it comes to unequal reward distribution to their disadvantage.

3.4 Inequity aversion in dogs

It is known that different forms of cooperation are common across various social carnivores. Cooperative hunting has been reported in African wild dogs (Creel and Creel, 1995), wolves (Mech, 1970), lions (Stander, 1992) and spotted hyaenas (Kruuk, 1972). Communal breeding and alloparenting, when members of a social group rear offspring that is not their own, was observed e.g. in African wild dogs and wolves (Creel at al., 1997; Harrington and Mech, 1983).

The domestic dog (*Canis familiaris*), like its ancestor, the wolf, is a highly social species that shows tendencies towards group territorial defence and cooperative hunting (in free-ranging feral dogs) (*Scott and Fuller, 1965; Nesbitt, 1975; Daniels and Bekoff, 1989; Thomas, 1993; Boitani et al., 1995; Pal et al., 1998*). In free-ranging dogs it was found that cooperation of individuals in intergroup conflicts is dependent on group size, age, sex and affiliative behaviour (e.g. tail wagging, playing, resting in physical contact) (Bonanni et al., 2010). In species with dominance hierarchies, where high-ranking individuals often have priority access to resources, it is expected that dominants are more motivated to defend this resources against

intruders. Further more, the costs of joining defence actions may be outperformed by better fighting abilities (Nunn, 2000, Nunn and Lewis, 2001, Nunn and Deaner, 2004). It was found that high-ranking dogs and juveniles cooperate more often when facing another group with more members, as well as individuals with more affiliative partners are more likely to participate in intergroup conflicts. There are two possible hypotheses about the connection of affiliative behaviour and cooperation. First, it has been suggested that cooperation is motivated by positive emotional states associated with specific partners with whom an individual had positive experiences in the past (Schino et al. 2007, 2009; Schino and Aureli, 2009). Second, Bonnani et al. (2010) raise the possibility that kin selection promotes cooperation in dogs if affiliative relationships are primarily established between closely related individuals.

Dogs cooperate not just with conspecifics (Boitani et al., 1995; Butler et al., 2004) but also with humans (Naderi et al., 2001). The close cooperation observed between humans and dogs might partly be due to domestication: for more than 10.000 years (Savolainen et al., 2002) dogs have been selected to live and communicate with humans (Miklosi 2008). Based on this cooperativeness one could expect that they have expectations about what to receive in comparison to another present dog and respond in some certain way to unfair distribution of rewards.

First evidence for a sense of fairness in domestic dogs came from a study by Bekoff (2004), investigating social play in canids. He observed that young dogs that did not engage in fair play were excluded from play sessions, and their conspecifics left if the expelled individual tried to rejoin the play group. Bekoff has argued that individuals that do not play fairly lack the opportunity to learn how to cooperate and negotiate social agreements, which, in turn, may have negative impacts in the future.

As dogs are used to be provided with food by their owner in their daily life, a modified form of the exchange paradigm is suitable to test inequity aversion in dogs as well. In an experimental setting similar to Brosnan et al. (2003, 2004) and van Wolkenten et al. (2007), Range et al. (2008) investigated if dogs react to unequal treatment when interacting with a human experimenter. Instead of exchanging a token with the experimenter, dogs had to give the paw on command, which most dogs are trained

on. Each subject faced four different conditions where they either were treated equally, or reward or effort varied, and in two control conditions where the subjects were tested alone. First, both subject and partner received a low-value reward (equity test), second, the partner received a lower-value reward compared to the partner (quality inequity test), third, the subject was not rewarded whereas the partner obtained a low-value reward (reward inequity test) and fourth, both dogs received a low-value reward but the subject had to work for it whereas the partner got it without any effort (effort control). In the control conditions the individuals first received the low-value reward for giving the paw (assessment condition), second, the animalôs action remained unrewarded (no-reward condition). Results showed that compared to the equity condition subjects stopped significantly earlier if they had to give the paw and were not rewarded for it while they witnessed the partner receiving a piece of food for giving the paw (reward inequity test). Furthermore, comparing social and asocial conditions it was found that not the mere absence of rewards resulted in an early refusal to give the paw but the presence of the rewarded partner in contrary to the unrewarded subject. Different to some of the primate studies, dogs did not react to differences in effort.

3.5 Research questions and hypothesis

It seems that dogs compare their own gains to those of a partner and react negatively if they face unequal, disadvantageous rewarding. We know that the presence of a favoured partner is the crucial factor that leads subjects to stop to cooperate with the experimenter by refusing to give the paw, but it has not been explored whether the dogsôsocial relationship with this partner and/or their individual character influences how they respond to unequal rewarding.

Aside from the dogs presented in the study of Range et al. (2008) some more dogs were tested with exactly the same procedure. All dog pairs that had underwent the inequity aversion task were tested in four additional tests, three of them conducted with both dogs present and one with the subjects alone. With these tests we aimed at examining the subjectsô motivation, attentiveness towards their partner and their relationship. Further information was gathered by a questionnaire that recorded the dominance hierarchy of the dogs perceived by their owners. We hypothesized that

this additional information will help to get a better understanding about the results obtained in the inequity task.

One would expect that dogs that are more attentive to the conspecific in the independent tests would also look more often and/or longer at the partner in the inequity aversion task and should stop earlier to give the paw if they face inequality. If motivation per se plays a role, high levels of motivation should be reflected in fewer refusals to give the paw and longer endurance. Furthermore, it is supposed that dogs in close social relationships show lower levels of inequity aversion as it was shown in chimps (Brosnan et al., 2004). Finally, based on former observations of intergroup conflicts (see above) we expect dominant dogs be more cooperative and, as such, more sensitive to unequal rewarding.

4. Material and Methods

4.1 Subjects

Subjects that participated in the following tests were privately owned pet dogs. They were recruited by contacting their owners who were listed in the data base of the Clever Dog Lab, Vienna, or in the data base of the Department of Ethology, Eötvös Loránd University, Budapest. Testing took place either in the Clever Dog Lab or at the ownerôs home from October 2007 to March 2008 and in September 2008 in Austria, and in the facilities of the Eötvös Loránd University from March to June 2008 in Hungary. Selection criterion was that two dogs, each at least one year old, belong to the same owner and lived in the same household. Some of the dogs already participated in various studies in Vienna or Budapest and some of them were naïve to testing. All dog owners voluntarily participated in this study.

38 dogs were tested in sum, whereof 10 dogs did not perform appropriately in the inequity task as they were not used to give the paw on command. 6 more dogs that did not reach the criteria in the no-reward control condition (NR) in the inequity task were excluded. Thus, 22 dogs remained for statistical analysis (15 Austrian dogs, 7 Hungarian dogs). These dogs were from 8 pure breeds (7 Border Collies, 2 Flat Coated Retrievers, 2 Golden Retrievers, 1 American Staffordshire Terrier, 1 Labrador Retriever, 1 Rottweiler, 1 Welsh Terrier, 1 Dachshund) and different mixed breeds (1 Australian Shepard-Collie Mix, 1 Labrador Mix, 4 others). Their age ranged from 1 to 10 years (mean = 4,91 years, SD = 3,04 years).

4.2 Questionnaire

Owners had to fill in a questionnaire (see appendix) in order to receive some general data about their dogs and to get an insight into the relationship between the dogs.

4.3 Testing schedule

Each dog underwent 5 different tests, the Inequity Aversion Task (IA), the Novel Task (NT), the Attention Task (AT), the Co-Feeding Task (CF) and the Favourite Toy Task (FT). In the Novel Task and in two asocial conditions of the Inequity Aversion Task dogs were tested alone. In the social conditions of the Inequity Aversion Task and in

the remaining three tasks dogs were tested in pairs. The IA was conducted on three days, trial 1 and 2 of the NT and the AT were run on day four and trial 3 and 4 of the NT, the CF and the FT were conducted on another day. The dogsô performance in the NT, AT, CF and FT was finally linked to the IA.

4.4 Inequity Aversion

To see if dogs are sensitive to unequal treatment, a test consisting of 6 different conditions was established. Dogs were either tested alone or together in pairs according to the different conditions.

The Inequity task consisted of 4 social (partner present) and 2 asocial conditions (partner not present). In all of the 6 conditions two different food rewards were present, both clearly visible for the dog and placed in a plastic food bowl which was divided into two compartments. One compartment was filled with a high-value reward (sausage, 5 x 5 mm) and the other one was filled with a low-value reward (bread, 5 x 5 mm). In the social conditions dogs were sitting side by side fixed by their leashes to the wall and the dogsôowner was standing silently behind them in the middle. In the asocial conditions, one dog was fixed by the leash to the wall with the owner standing behind him. In the social conditions a wooden block (60 l x 10 w x 10 h cm) on the floor provided a psychological barrier between the dogs.

The main procedure was the same for all conditions: The experimenter kneeled in front of the dogs within armôs reach with the filled food bowl placed on the floor between the experimenter and the dog(s). Before the test started, each dog was offered a piece of sausage. Then dogs were asked alternately to give the paw by the experimenter. If the dog did not give the paw to the experimenter on the first command, the command was repeated. After repeating the command for 5 times the experimenter addressed the dog by its name and again asked it to give the paw. The test was terminated if the dog refused to give the paw after a maximum of 10 commands. Furthermore, the dog was only allowed to give the paw to the experimenter when it was in a sitting position. If the dog was standing or lying, the experimenter asked it to sit and then commanded it to give the paw. Again, after 5 commands to sit the dog was addressed by its name and the experimenter asked for

another 5 times if necessary. If the dog refused to sit the test was terminated. Eye contact with the dogs was avoided during testing.

Each dog was tested in all 6 conditions, and they served also as models in the 4 social conditions of their partners. The first asocial condition was the assessment condition (AC) where the dog was rewarded for giving the paw by offering a low-value reward. This first condition was immediately followed by the second one, the no-reward control condition (NR). In the NR condition (Fig. 1a), the dog was commanded to give the paw but was not rewarded for it, furthermore, the experimenter pretended to give the treat to an imaginary dog next to the subject and moved it back into the food bowl (in order to control for the movement of the food). The social conditions differed in reward distribution, effort and value of the food item. In the equity test (ET), both dogs had to give the paw on command and both were rewarded with a low-value reward for the correct response. The quality inequity test (QI) differed in the food item obtained. Both dogs had to perform but the partner dog received a high-value reward whereas the subject received a low-value reward. In the reward inequity test (RI) the partner was offered a low-value reward for giving the paw but the subject was not rewarded for its action (Fig. 1b). Finally, in the effort control (EC) condition, the partner got a low-value reward without having to perform whereas the subject had to give the paw to receive the low-value reward.

Conditions consisted of 30 trials each. One dog served either as the subject or the partner throughout all 4 conditions before the roles were reversed. The asocial conditions were conducted on one day and in each case two social conditions on two additional days with a 15 min break between them. The order of the social conditions was counterbalanced with the exception that we never started with the RI condition in order to avoid frustrating the dogs.

(a) (b)

Figure 1. Experimenter pretends to give the low-value reward to an imaginary conspecific in the NR condition of the Inequity Aversion task (a). Partner dog on the right is rewarded after giving the paw to the experimenter in the RI (b).

For each condition the total number of paw given by the subject was coded as well as the number of prompts to give the paw and to sit. Looking at the partner, physical contact with the partner, looking at the owner and stress-induced behaviours (i.e. gaze avoiding, mouth licking, yawning, vocalization) were coded. Only dogs that gave the paw for at least 10 times in the NR condition were considered for further analysis.

4.5 Novel Task

4.5.1 Experimental set-up

To see how motivated the dogs are to work on a new task, they were confronted with an unfamiliar problem. In the testing room, a dog toy (Dogfighter, produced by Nina Ottosson) that was designed to store food behind hollow blocks was screwed to the floor. The toy consisted of a wooden plate (36 cm in diameter) with seven deepened slots and seven corresponding wooden blocks. Each slot was enlarged on one side and the single blocks could be put into and moved along them. To receive the hidden food reward the baited block had to be removed by the dog using its muzzle or paw to lift it up or knock it over.

Figure 2. Picture of the dogfighter used in the NT (by Nina Ottosson)

4.5.2 Procedure

Dogs were tested individually with the toy. The owner was asked to stay approximately 0.5 m in front of the toy with the dog sitting next to him. The experimenter kneeled next to the toy, addressed the dog by its name, showed him a food reward (dry food pellets) and let him sniff on it. The dog then could observe the baiting of the blocks. For trial 1 and 2, four hollow blocks were put into the toy and arranged at the narrow side of the slot (Fig. 2). For trial 3 and 4, two blocks were baited and the task was increased in complexity by putting two additional, empty blocks in front of the baited blocks. In this case, three blocks had to be removed to grab one food item.

After arranging the blocks, the experimenter stepped aside and the dog was released by the owner with a command to search for the food. A trial lasted 3 min and was terminated either if the dog had grabbed all rewards or after 3 min if the dog was not able to get all food items within that time limit. Dog owners were allowed to encourage the dog (i.e. ñwhere is itò, ñfindò) if it lost interest in the toy (e.g. started to explore the testing room) but were not allowed to touch the toy.

Figure 3. Subject is working on an unfamiliar problem using its muzzle to remove the baited blocks.

Percentage of total time spent exploring the toy (defined as manipulating the clocks with paw or muzzle was measured as well as the percentage of total time spent manipulating with muzzle or paw. Time spent looking at the owner and latency to first look at the owner was coded. Proximity to the toy was measured and calculated as ñnear toyò when the dog was directly next to the toy and could reach it with its paw or mouth, and ñnot nearò when the dog was at a distance that it still had to take at least one step to reach the toy. Talking of the owner in percentage of total time within a trial was coded as well.

4.6 Attention

The aim of this test was to examine if and to what extent one dog pays attention to the activities of its conspecific and if the conspecificôs behaviour or a dogôs own previous experience influences the subjectôs searching behaviour. Like in the inequity task und the following tests (Co-feeding, Favourite toy) the two dogs were tested together.

4.6.1 Experimental set-up

A v-shaped cardboard (80 x 40 x 40 x cm) was positioned close to the wall and served as a visual barrier. Dogs behind the screen could not see what was going on in the testing room and had no visual contact to the conspecific and the experimenter. In front of the screen 3 cups to hide a ball (C1, C2, C3) were placed on

the floor and arranged in a triangle (see Figure 3). The distance from the screen to the first cup was approximately 2 m as well as the distance from C1 to C2 and C2 to C3.

4.6.2 Procedure

At the beginning, the owner and both dogs were present in the testing room. The dogs were leashed and sitting to the left and the right of the owner. The dog owner was told to remain silent during the experiment in order not to influence the dogs. In trial 1, the experimenter approached the dogs, addressed them by their name and moved a ball in front of them. Subsequently, the owner led one dog (B ï the subject) behind the screen and made sure that it could not see the further actions. The experimenter then headed towards C1 and put the ball into it without making any noise when the ball touched the bottom of the cup. After dropping the ball, the experimenter showed her empty palms to the observing dog (A). The experimenter walked on to C2 and C3 and stopped at them for the same amount of time as the hiding of the ball lasted. During moving along the cups, eye contact to the partner dog (A) was avoided. Only the partner dog (A) could see this procedure. After hiding the ball, the owner allowed the subject waiting behind the screen (B) to leave its place and stay next to the screen. Dog A was unleashed and released by the experimenter by a command to search for the ball (i.e. ñwhere is itò, ñfindò). The subject (B) remained leashed but could watch the conspecific grabbing the ball (Fig. 3). The task was terminated after the partner dog (A) successfully removed the ball from C1. The owner called the partner back and took him outside while the subject (B) stayed in the testing room.

The returning owner went next to the subject (B) and trial 2 started. The experimenter again moved the ball in front of the dog and then asked the owner to move the subject (B) behind the screen. After B was prevented from watching, the experimenter headed towards C1 but did not put the ball in this cup. The experimenter moved on to C2, put the ball into it without making any noise and then headed towards C3. Again, the experimenter spent the same amount of time at each cup. Subsequently, the owner told the subject (B) to emerge from behind the screen, the owner unleashed it and commanded it to search for the ball. The task was

terminated after dog B grabbed the ball. It was noted in which cup the subject searched for the ball firstly.

After this the dog A was brought back into the testing room by the owner, and trial 1 was repeated with a reversed role played by the 2 dogs. Now dog A was the subject and dog B was the observer. The ball again was placed in C2. In the next step, B was brought to the adjacent room and the subject (A) remained in the testing room. The procedure was the same as in trial 2 but the ball was now placed in C1 while subject A remained behind the wall, and A then was commanded to search for it.

Figure 4. The ball in the cup is retrieved by the released dog while the leashed conspecific is allowed to watch.

Cups that served for hiding were alternated between dog pairs. In the same manner as described above different cups were baited (i.e. C2 ï C1 ï C1 ï C2, C1 ï C3 ï C3 ï C1). For half of the dog pairs, the experimenter started at C1 and for the other half she started at C3 to avoid any side preference. The dogsôroles (observer or subject) and the cups were alternated in order to see if the decision of the released dog to which cup to go first was influenced by the performance of his conspecific or by his own experience. In case the performance of the conspecific had a strong impact on the dog, we expected it to go to the cup where its conspecific found the ball in the previous trial.

Each dog was searching for the ball twice and for both decisions it was noted what the dog had observed beforehand and which cup he had chosen.

4.7 Co-Feeding

The influence of the social relationship between the dogs was further observed in a food related context where dogs had the opportunity to feed simultaneously. To avoid any crucial conflicts between the dogs, the owner was first asked if the task might cause problems for the dogs. All owners agreed on testing their dogs, thus all dogs were tested in this task.

4.7.1 Procedure

The dogs were restrained by their leashes and the owner was standing silently in between them, holding the leash in her hand. The experimenter walked to the dogs, addressed them by their names, presented them some food reward (a handful of dry food pellets in the experimenterôs hand) and let them sniff on it. The experimenter then placed a circle of 12 food items on the floor approximately 4 m ahead of the dogs. The distance between the single food pieces was 30 cm. After arranging the food items, the experimenter walked back to the owner and the dogs, took the leashes from the owner, positioned herself between the dogs and unleashed them. The experimenter still kept them on the collar and released them by a command to go for the food when they where at an equal distance from the food (Fig. 4). After all rewards were eaten by one or both dogs, both were called back by their owner and the same procedure was repeated three more times.

4.7.2 Coding

The total number of food items each dog ate per trial was measured. One dog could reach a maximum of 12 rewards if it ate all the treats or a minimum of 0 if it did not feed at all. Avoiding was noted if one dog was near to the last food reward but moved away when the conspecific as well got to the last piece. Delayed start was accounted if one dog hesitated to approach the food circle after they were released. If a dog avoided the partner who had already left the starting position and took another direction to it this dog was recorded as making a detour. Growling and snapping at the conspecific was noted as aggressive behaviour.

Figure 5. Arrangement of food items on the floor with both dogs feeding in parallel.

4.8 Favourite Toy

Similar to the Co-feeding task, dogs in the Favourite toy task were put in a situation which would give additional information about the relationship between the dogs but this time, instead of food, a toy was provided as a resource.

4.8.1 Procedure

The dog owner who kept both dogs on the leash was standing in the middle of them and he was told not to talk to them or interact with them in any way once they were released. A toy was shown to the dogs and moved in front of them by the experimenter. The experimenter then turned around and walked to the rear side of the room where she placed the toy on the floor. She remained here and recorded the behaviour of the 2 dogs with a hand held camera. After placing the toy, the experimenter asked the dog owner to release the dogs simultaneously by command (i.e. ñwhere is itò, ñfindò), (Fig. 5). The Favourite toy task consisted of 4 trials, 2 min each. Two different toys were used alternately: 2 times a dog dew and 2 times a ball. The behaviour of the dogs was observed while both the experimenter and the owner were standing passively in their positions.

4.8.2 Coding

It was recorded which dog grabbed the toy first, and how long each dog was in possession of the toy throughout a trial (total percentage of time). The duration of gazing at the conspecific, gazing at the owner, gazing at the experimenter or looking elsewhere was measured and was calculated as percentage of total time of trial. Additionally, dominance behaviour like mounting, putting ones paw or head on the body of the partner dog was coded for each dog.

Figure 6. Dog with the dew is watched from distance by its conspecific in the Favourite toy task.

4.9 Data analysis

Experiments were recorded with a digital video camera (JVC HD Everio GZ-MG20E) which was fixed on a tripod and appropriately arranged in a way that all behaviours of the dogs were captured in the IA, NT, AT and CF. For the FT, the experimenter manually handled the camera and followed the movements of the dogs. Tests that were conducted in the testing room of the Eötvös Loránd University, Budapest, were recorded by a video system (Pan tilt zoom cameras) that consisted of four single cameras, each of them fixed on one side of the room. The output of the camera system was a movie file on the personal computer outside the testing room which rendered the recordings of all four cameras in one picture.

The videos were analysed with the Solomon Coder beta 081122 (© András Péter) and latencies and durations of different actions (as stated for each test) could be extracted.

4.9. Statistics

For statistical analysis the programmes Microsoft Excel 2003 and SPSS 15.0 were used. Graphs were created with SigmaPlot 10.0. Due to the low sample size and not normally distributed data the results of the IA were compared to the results of the NT, AT, CF and FT using nonparametric tests like the Mann-Whitney U-Test and the Kruskall-Wallis Test.

5. Results

In order to investigate whether motivation, attentiveness to a partner or the relationship of two partners influence their inequity aversion, the performance of each dog in the independent experiments was related to the RI (reward inequity) and the NR (no reward) conditions of the inequity task. This was done as it was shown that subjects refused to give the paw significantly earlier in the RI, but not in the QI (quality inequity) and the EC (effort control) conditions, compared to the social (ET: equity test) and the asocial (NR: no reward) baseline conditions.

5.1 Motivation in the Novel Task and behaviour in the Inequity Aversion task

The 22 dogs were assigned to 2 groups based on their performance in the NT. The first group consisted of dogs that were highly motivated to solve an unfamiliar problem and spent more than 50 % of the total time exploring and manipulating the toy. The second group contained dogs that spent less than 50 % of the time with explorative and manipulative behaviour. To investigate whether the general motivation of the dogs also influenced their performance in the IA, we analyzed whether the motivation of the 2 groups from the NT was indicative of the total number of paw given in one of the social and one of the asocial conditions of the IA.

As predicted, we found that dogs that were more motivated to solve a novel task also gave the paw for a higher total number when tested alone in the NR condition of the IA, even if they were not rewarded for this action (Mann-Whitney U-Test: $N_{>50\%} = 16$, $N_{<50\%} = 6$, $Z = - 3.628$, $P = 0.0001$, after Bonferroni correction: $P < 0.05$; Figure 7). They also looked more often at the owner in condition NR (Mann-Whitney U-Test: $N_{>50\%} = 16$, $N_{<50\%} = 6$, $Z = - 2.089$, $P = 0.040$; Figure 8). In contrast, however, when comparing the performance of the same 2 groups in the social condition RI of the IA, no significant difference was found in the number of giving the paw (Mann-Whitney U-Test: $N_{>50\%} = 16$, $N_{<50\%} = 6$, $Z = - 0.521$, $P = 0.641$; Figure 7) or in looking at the owner (Mann-Whitney U-Test: $N_{>50\%} = 16$, $N_{<50\%} = 6$, $Z = - 0.296$, $P = 0.802$). These results suggest that the dogsôperformance in the asocial NR condition is modulated by the general motivation of the dogs to work for the experimenter. It seems, however, that the mere presence of a conspecific partner makes a difference and has a dismotivating effect on the dogs that showed high motivation in the NT task

(Wilcoxon matched-pair test: n = 16, Z= -2.575, P = 0,010, corrected P < 0.05). Those dogs, however, that had explored and manipulated in less than 50 % of their time in the NT gave the paw similarly often in the social RI and in the asocial NR conditions (Wilcoxon matched-pair test: n = 6, Z= -1.577, P = 0,115, corrected P > 0.05), indicating that their motivation was not significantly influenced by the presence of a partner (see Figure 7).

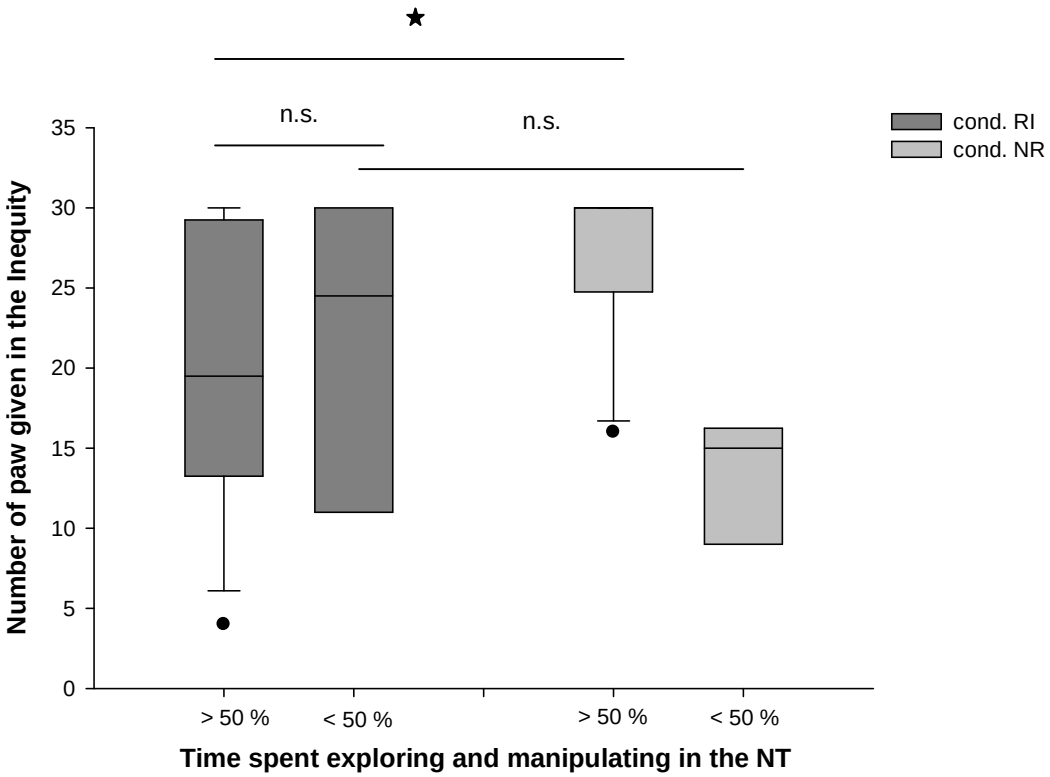

Figure 7. Number of paw given in the IA conditions RI and NR for more (N = 16) and less motivated dogs (N = 6) in the NT.

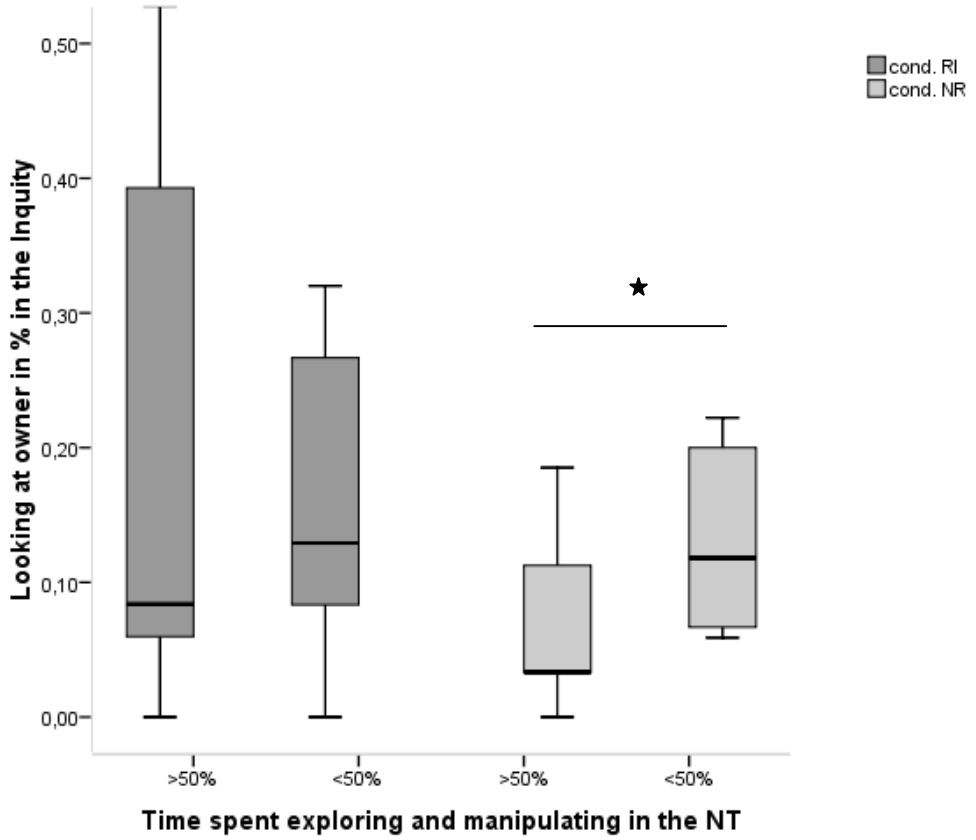

Figure 8. Time spent looking at the owner in % in the conditions RI and NR for more (N = 16) and less motivated dogs (N = 6) in the NT.

To investigate whether dogs that are less motivated and may be easily frustrated look at the owner longer or earlier in the NT, their explorative and manipulating behaviour was compared to their looking behaviour. The less motivated dogs were expected to look at the owner for a longer duration as well as to gaze at their owner earlier. This is what we found, since dogs that explored and manipulated less than 50 % of the time were looking at the owner for a longer duration in the NT than dogs that were more motivated (Mann-Whitney U-Test: $N_{>50\%}$ = 16, $N_{<50\%}$ = 6, Z = - 2.030, P = 0.040; Figure 9), there was no difference in the latency to the first look at the owner (Mann-Whitney U-Test: $N_{>50\%}$ = 16, $N_{<50\%}$ = 6, Z = - 0.886, P = 0.407).

Figure 9. Time spent looking at the owner in the NT in % for more (N = 16) and less motivated dogs (N = 6) in the NT.

Furthermore, the looking behaviour in the IA conditions RI and asocial NR was analysed. Dogs were assigned to 2 groups according to the total number of paw given in the respective condition (1 = 21 ï 30, 2 = 0 ï 10). This was done to differentiate between dogs that showed more motivation in the IA and kept on working till the end of all 30 trials and dogs that stopped earlier. There was a significant difference in the looking behaviour between the groups for condition RI. Dogs that refused to give the paw earlier looked at the owner more often than dogs that gave the paw for at least 20 times (Mann-Whitney U-Test: $N_{>20}$ = 11, $N_{<10}$ = 4, Z = - 2.358, P = 0.018; Figure 10). No significant difference could be found in the relation of readiness to give the paw and looking at the owner in the NR condition (Mann-Whitney U-Test: $N_{>20}$ = 14, $N_{<10}$ = 2, Z = - 1.799, P = 0.100). Again, these results show that the presence of the partner plays a role. Witnessing the partner getting a reward resulted in increased gazing at the owner and not the absence of the food reward per se. It has to be emphasized that there were only 2 individuals in the less motivated dog group in cond. NR.

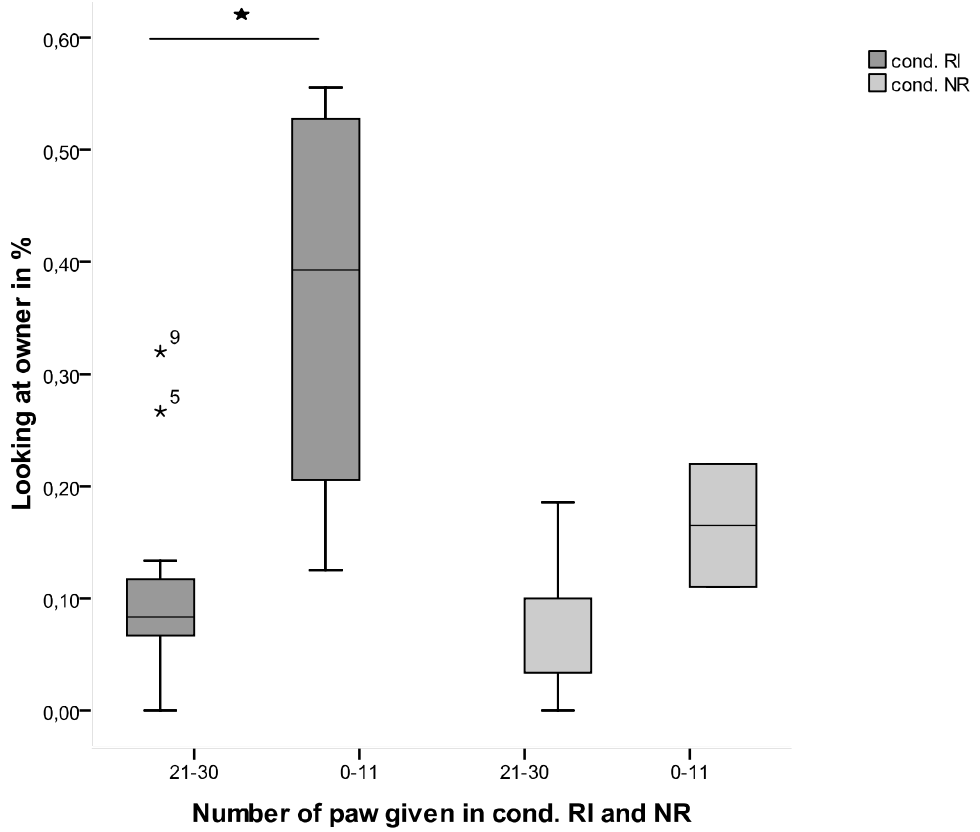

Figure 10. Time spent looking at the owner in % for dogs that gave the paw 21 ï 30 times (RI: N = 11, NR: N = 14) and 0 ï 10 times respectively (RI: N = 4, NR: N = 2).

5.2 Effects of attentiveness to the conspecific

According to their performance in the AT, the dogs were assigned to 2 groups. Group 1 consisted of dogs that went to the same bowl as their conspecific beforehand when searching for the ball (N = 10), whereas dogs that did not follow their conspecific to a certain place were assigned to group 2 (N = 12).

To investigate if dogs that were more attentive towards their conspecific stopped earlier to give the paw in the IA when facing unequal treatment, both groups were compared in their total number of paw given in condition RI. It was expected that the more attentive dogs in the AT would be more attentive to their partner also in the IA and better notice that they are treated differentially. We, however, found no difference between the 2 groups (Mann-Whitney U-Test: N_{follow} = 10, $N_{notfollow}$ = 12, Z = -0.600, P = 0.582; Figure 11).

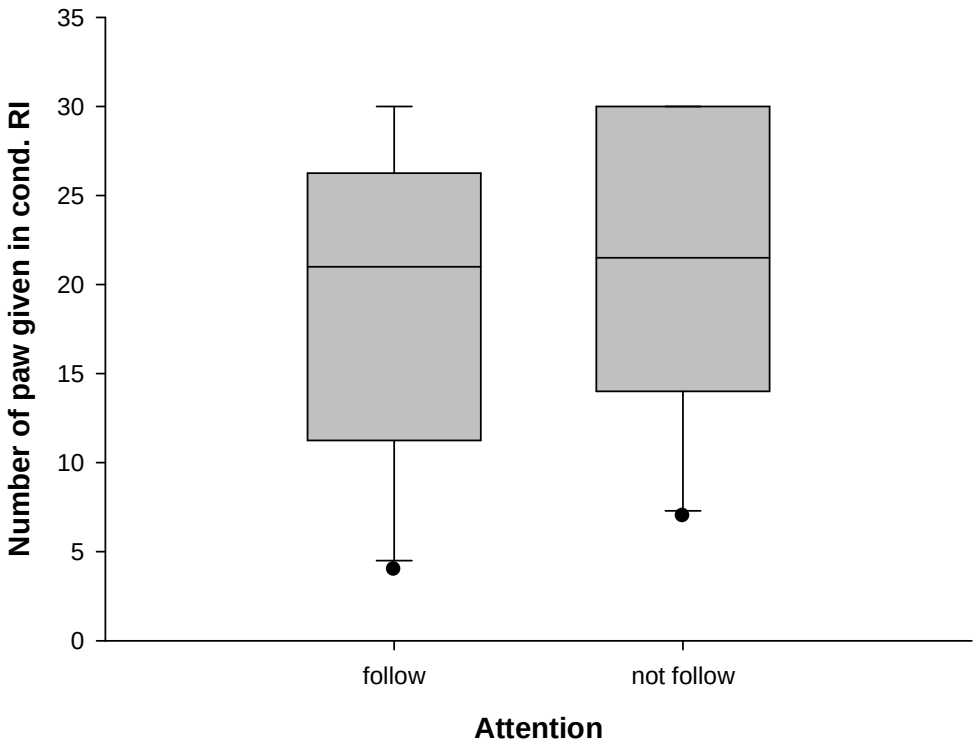

Figure 11. Number of paw given in the IA condition RI for more (N = 10) and less attentive dogs (N = 12).

5.3 Social relationship, sex and Inequity Aversion

The dominance ranks of the dogs are a crucial factor that determines the relationship of dog pairs. Based on their ownerôs judgement recorded in the questionnaire, dogs were divided into dominant and subordinate individuals. The dogsôperformance in the RI condition of the IA was compared to their rank, with the prediction that subordinate dogs should be more consistent in giving the paw as they may be accustomed to have disadvantages to the dominant in their daily life. Also as argued earlier, we expected that dominant dogs would be more cooperative, and consequently, pay more attention to inequity. On the contrary, we found no significant difference in the total number of paw given between dominant and subordinate dogs (Mann-Whitney U-Test: N_{dom} = 12, N_{sub} =10, Z = - 0.666, P = 0.539) (Figure 12).

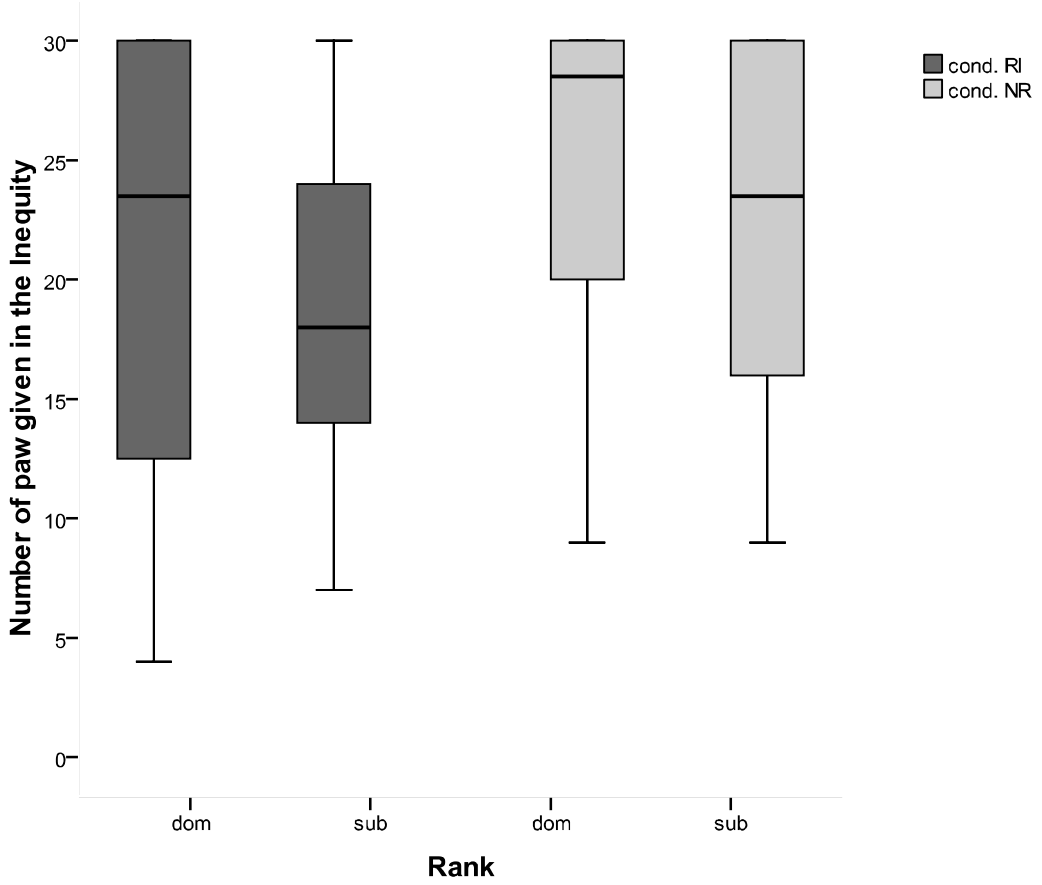

Figure 12. Number of paw given in the conditions RI and NR (N_{dom} = 12, N_{sub} = 10, Z = - 0.459, P = 0.674) for dominant (N = 12) and subordinate dogs (N = 10).

As it is known from primates that socially more tolerant individuals show less inequity aversion, the social tolerance and its effects on the performance in the IA was investigated in various ways. We expected that tolerant pairs show less inequity aversion.

Firstly, the tolerance of each dog pair was assessed based on the dogsôbehaviour in the CF test. If none of the dogs avoided the other or displayed aggressive behaviour we counted them as a tolerant pair. We found, however, that dogs that showed signs of avoidance behaviour in the food related context (CF) did not perform differently in the condition RI than dogs that did not avoid the conspecific (Mann-Whitney U-Test: $N_{noavoiding}$ = 13, $N_{avoiding}$ = 9, Z = - 0.304, P = 0.794; Figure 13).

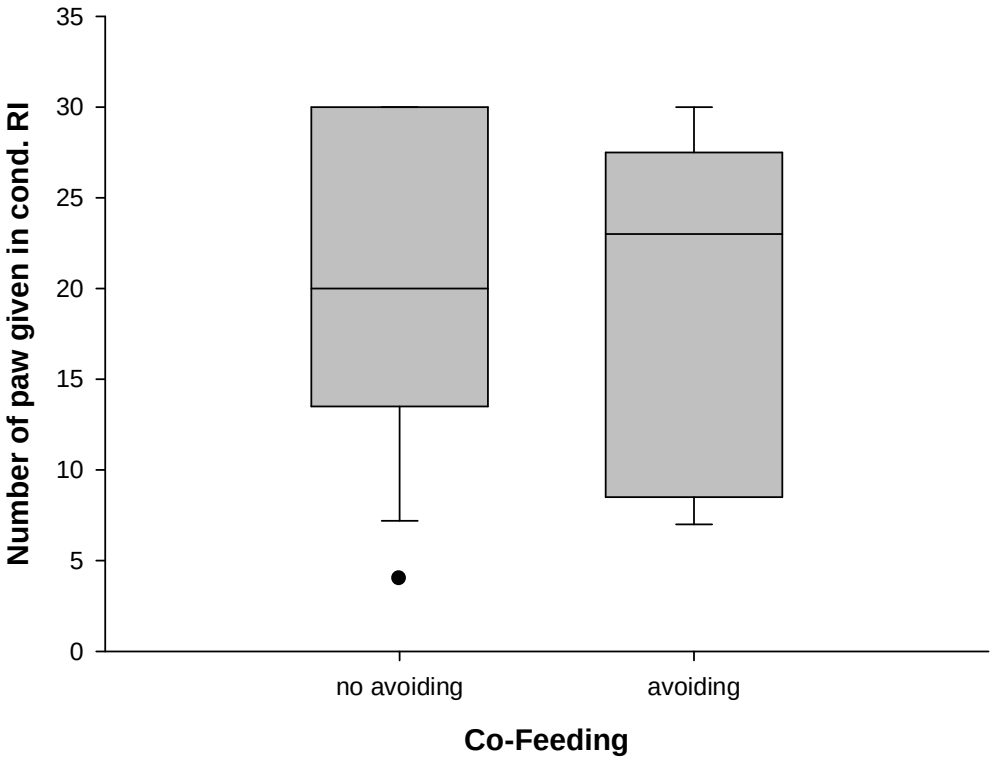

Figure 13. Number of paw given in the IA condition RI for dogs that did not show avoiding behaviour (N = 13) and dogs that did (N = 9) in the CF.

Secondly, we investigated how long the dogs had been living together in the same household. Dogs that had been living together in a household less than 2 years were put together in one group, dogs that were living together for more than 2 years were summed in another group. The third group contained dog pairs that did not live together but were well socialised with each other. No significant difference between the three groups in the RI condition of the IA was found (Kruskall-Wallis Rank Test: $N_{<2} = 7$, $N_{>2} = 11$,$N_{nottog} = 4$, $\chi^2 = 1.101$,$P = 0.577$; Figure 14). These results suggest that the years spent together do not have a crucial impact on the performance of the IA.

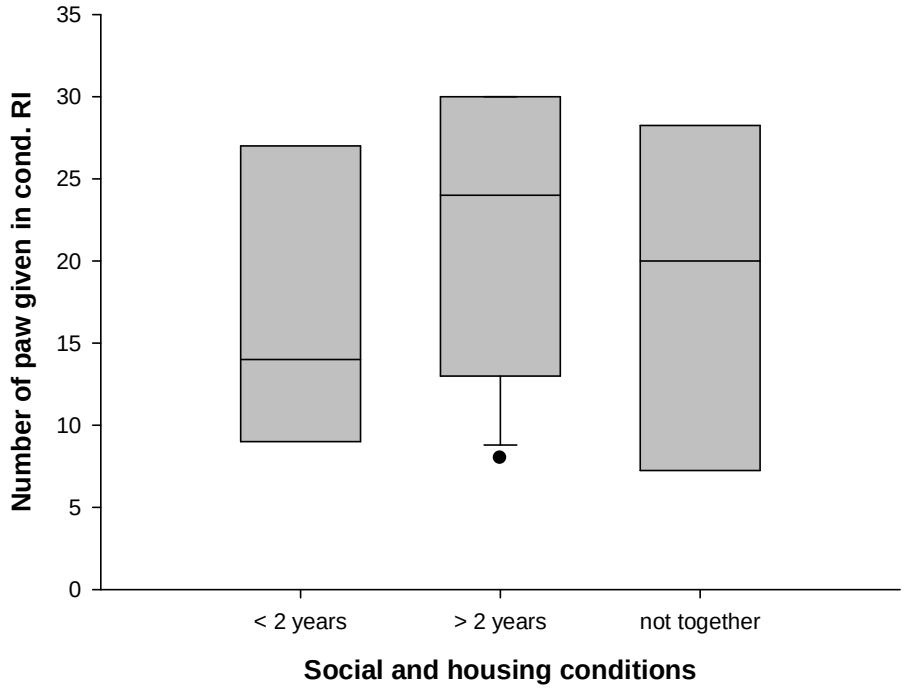

Figure 14. Number of paw given in condition RI for dogs that were living together in a household for less (N = 7) or more than 2 years (N = 11) and dogs that where living in to separate households (N = 4).

Thirdly, as the questionnaire was designed to get a more comprehensive insight into the relationship between the two dogs, it was analysed if some other factors can control for the dogsô performance in the IA. Dogs that displace their conspecific if they want to get to a certain place were taken together in one group and dogs that do not displace their companion and allow them to lay next to them were put into the second group. Figure 15 shows that dogs those are more tolerant to their conspecific and do not displace him were less inequity averse in condition RI and gave the paw for a higher number (Mann-Whitney U-Test: $N_{displace}$ = 6, $N_{notdisplace}$ = 16, Z = - 2.345, P = 0.017)

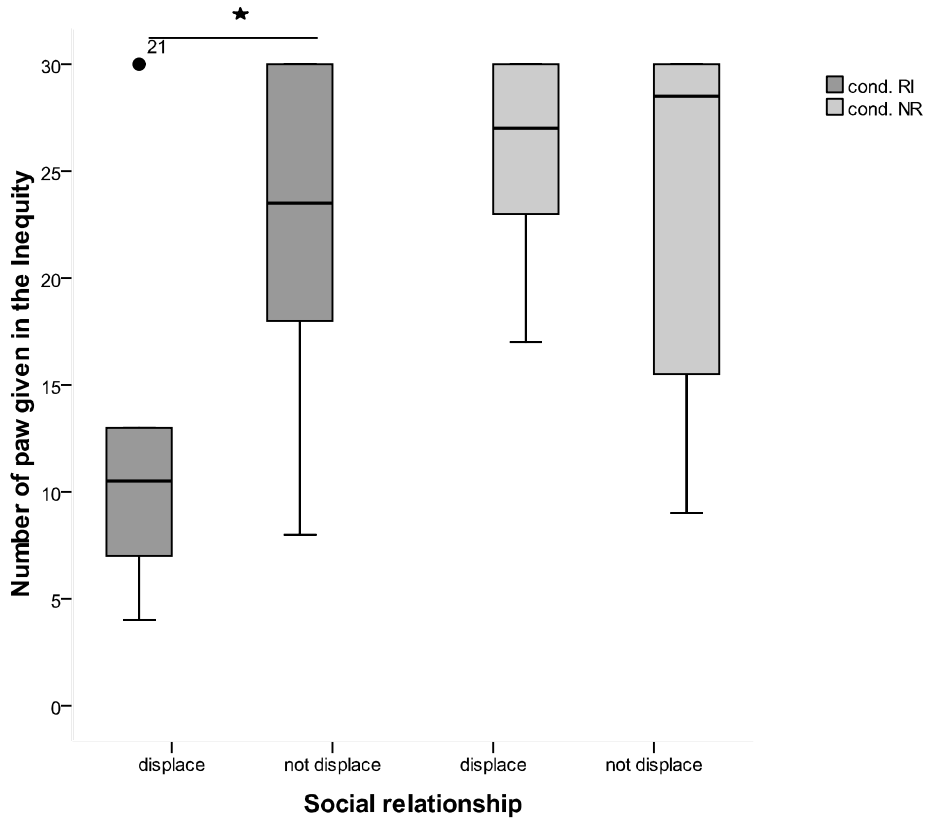

Figure 15. Number of paw given in the IA conditions RI and NR for dogs that displace (N = 6) respectively do not displace the conspecific from his place (N = 16).

Gender might affect the performance in dogs in the inequity task. Male dogs often outweigh females in bodyweight, size and power and consequently gain dominance over females. Furthermore, males defend resources like mates, so it is assumed that they should be more averse to inequity aversion, as they often enjoy prior access to resources. Comparing the total number of paw given in the social RI and the asocial NR condition to males and females, no difference according to gender was found (Mann-Whitney U-Test: RI: N_m = 7, N_f = 16, Z = - 0.249, P = 0.837; NR: N_m = 7, N_f = 16, Z = - 0.566, P = 0.630) (Figure 16).

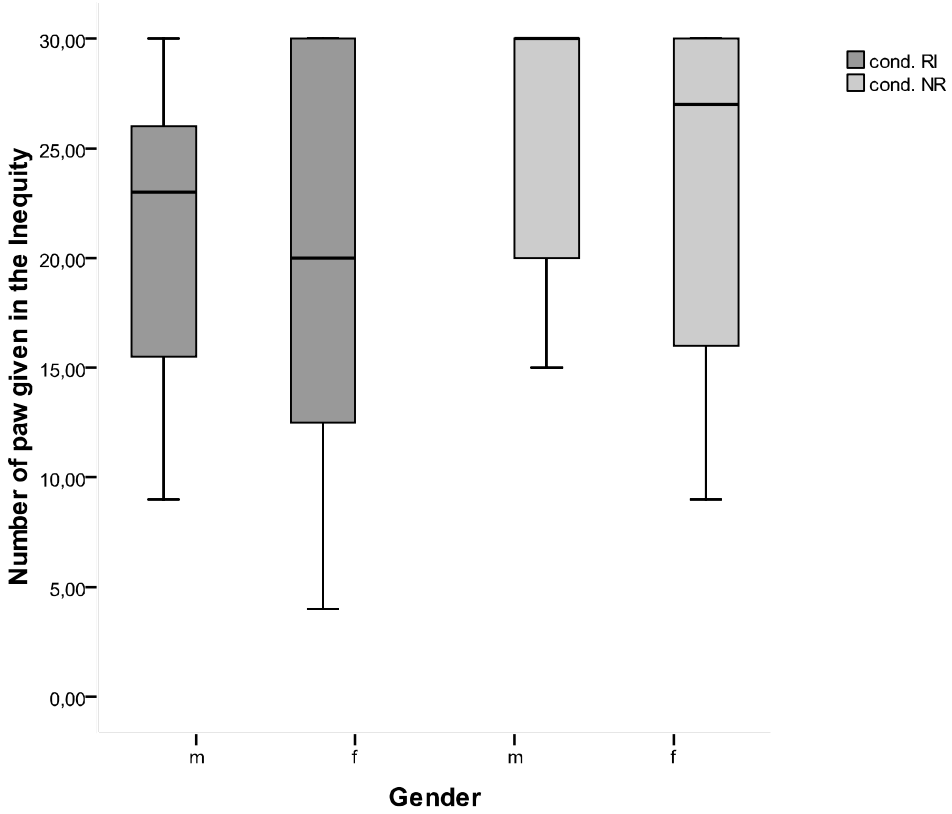

Figure 16. Number of paw given in the IA conditions RI and NR for males (N = 7) and females (N = 15).

6. Discussion

Although several studies on non-human primates and dogs revealed their tendency to react to unequal outcomes, little is known about factors influencing their aversion to inequity. The aim of our study was to determine what factors might play a role in dogsôreaction to inequitable outcomes by focusing on dog-dog relationship and the dogsôindividual characteristics which were investigated by four experiments as well as by a questionnaire. The results of these experiments were then linked to the results of the inequity study.

We found that motivation measured as persistency in the Novel Task, influenced the performance of dogs in the control but not the inequity condition suggesting that while motivation is important if the dog is alone, it does not drive the response of the dog in regard to inequity. When paired with a partner in the social condition, dogs with high motivation showed less endurance than compared to the non-social condition, as if the presence of the rewarded partner had a dismotivating effect. Moreover, the data revealed that in the social condition, dogs that quit cooperation with the experimenter at an early stage looked more often at their owner, that was not the case when they were tested without the rewarded conspecific. Their attentiveness to their partner, measured in a further experiment, was not predictive for the outcome of the IA. The behaviour of the dogs in the Favourite Toy and the Co-Feeding task neither allowed us to draw any conclusions regarding the results in the inequity task.

As it has been suggested that sex and rank affect the outcome of studies dealing with inequity aversion and several non-human primate studies controlled for those factors, it was investigated if those parameters might predict the results of the IA in dogs and maybe are similar to the findings in non-human-primates. We could not detect that any of those factors influenced subjectsôreaction to inequitable situations.

6.1 Motivation in the Novel Task and behaviour in the Inequity Aversion task

One approach to determine how the dogsômotivation/persistency may influence the outcome in the inequity aversion task was to link their performance in the main conditions of the IA to an independent problem solving experiment that provided

information about the dogsô overall motivation. Motivation detected in the NT was reflected in the non-social condition of the IA, but was no indicator for the behaviour in the social inequity condition.

This difference in performance within the highly motivated dog group may therefore be explained by the absence, respectively the presence of the conspecific. It seems obvious that the partner dog in the social condition has a dismotivating or at least distracting effect. Dogs belonging to the highly motivated group showed similarly high endurance in the NT as well as in the NR but they behaved differently when paired with a conspecific, showing less willingness to give the paw for a higher total number in the RI when paired with a partner that, in contrast to them, got rewarded for the same action. Facing and recognizing the difference in outcome for oneself compared to the partner and thereupon reacting with a higher refusal rate may be explained by the social frustration effect, a term introduced by Brosnan (2011). The frustration effect (Amsel and Roussel, 1952) is based on the individual and its own previous experience; in other words an individual that is used to receive a high value reward and is later on downshifted to a low quality reward or even omitted the reward, may react frustrated to this unexpected change and refuses the low quality treat or stops to cooperate. The general frustration effect cannot be the possible explanation for higher refusal rates in the RI condition, as both high-value and low-value rewards were present and clearly visible in the RI as well as the NR condition and there was no downshift in food quality from the NR to the IR. As the high motivated dogs only displayed higher levels of refusals in the social RI condition, the essential factor was not the absence of the food reward, but observing the conspecific getting rewarded. Only the social frustration effect can explain this difference, that is, the reason for frustration is not receiving a reward and seeing the partner dog getting a reward - the iniquitous outcome compared to itself.

Moreover, we had analyzed the dogsôlooking behaviour towards their owners. Less surprisingly, dogs in the less motivated group in the NT looked at the owner for a longer period of time than the highly motivated dogs that often solved the problem on their own within the given time. This may be considered as a kind of help requesting behaviour, as in our experiments the majority of the less motivated dogs first tried to grab the food items on their own but seemed to be frustrated when they failed to

relieve the baited clocks and looked at their owner, like they would ask their holder for help. In a study of Topal et al. (1997), behavioural analysis of dogs that were presented with a novel food-getting problem revealed that subjects first looked at their caretaker, what was interpreted as a social strategy of waiting as they expect the owner to solve the problem for them. Similarly, in a study from Miklósi et al. (2003), where dogs were presented with an insolvable problem it was shown that after approximately 1 min of unavailing attempts, dogs established eye contact to their owner. When e.g. facing a novel problem or a situation where a preferred toy is out of reach, dogsô with high levels of motivation might react with curiosity and interest to this challenge and keep on trying to solve the problem on their own, being persistent on working on it and do not care about their owner as they are focused on their job. Contrary, dogs with minor motivation might as well try to manage the situation on their own first but give up quickly and try to recruit their owner for their purpose, using him as a tool to achieve their goal. This implicates that the attention of the owner has first to be drawn to the dog, what furthermore can be achieved by barking at or looking at the holder. Our results seem to be in line with this presumption. Alternatively, it is possible that low motivated dogs spent more time with looking at their owner simply because they had more time to do so and the owner was interesting in their environment.

When analyzing if the same effect of motivation was found in the IA we found that the presence of the partner also had consequences on the looking behaviour in the inequity tasks. According to the total number of paw given in condition RI, dogs were assigned to two groups that contained individuals of either high or little motivation. In the social RI condition, dogs that gave the paw less than 10 times and, thus, were considered to be less motivated than the other dogs, looked significantly more often at the owner. Even if subjects initially kept on working, the omission of the reward later on did not simply result in cessation of the cooperation with the experimenter. In fact the undercompensated subjects increasingly looked back at their owner like they were confused by being left out while the partner receives a reward for the same effort. When tested alone, this effect was not found. The social frustration effect would again be a possible explanation for these results (Brosnan, 2011). Working next to a rewarded partner might increase frustration in the subject that furthermore reacts with an increased looking behaviour back at the owner. A lower level

explanation for higher gazing rates in less motivated dogs is also possible. As those dogs stop earlier to work for the experimenter, they have more time left to turn back to their owner and look at him, and since they quitted cooperating, they might expect something more interesting from their owner.

6.2 Attentiveness to the conspecific

Exchange of information (visual cues, social monitoring) that subsequently allows an individual to adjust its behaviour to those of another seems to be a prerequisite for cooperation. As reaction to iniquitous outcomes necessitates comparing the pay-off from itself to the ones of the other engaged party, individuals may check more frequently what the partner is doing and what it received for its action. In dogs, it was shown in several studies that they pay close attention to conspecifics and can rely on information given by a demonstrator (e.g. detour: Pongrácz et al., 2008; locate food: Asthon and Cooper, unpublished data; observing a conspecific model searching for hidden object: Range et al., 2008).

Attentiveness to the conspecific was investigated in the AT, with the aim to determine how an individualôs choice was influenced by what it has witnessed beforehand and thus how much attention a certain animal pays to its partner. Dogs that did choose the cup where the conspecific was beforehand were considered to be more attentive to the partner than dogs that did not follow the partner. However, no difference in the looking behaviour or the willingness to cooperate could be found between the more and less attentive dogs compared to the IA.

It is possible, that in the AT the partner is perceived as an informant, from whom the subject gains information about the hidden object and therefore is closely observed by the subject whereas in the IA, the food bowl respectively the experimenterôs hand that moves the piece of food is such a strong stimulus that the subject fixes its glance mainly to the treat. As data from the study of Range et al. (2008) revealed that dogs pay more attention to searching events than to a feeding model, this might explain why attentive dogs had chosen those cups where the conspecific went beforehand in the AT but did not check more often what it received in the IA. Furthermore, Range et al. also found that dogs are more attentive towards a human than a dog model. Since both conspecific and experimenter were present during testing, another possible

explanation is that dogs might generally be more keen on the behaviour of the human compared to the conspecific partner. Observing the partner might take just a quick glance from the corner of the subjectôs eye, which is too subtle to be measured compared to a directional look to the owner, which was clearly visible as the dogs had to move their head backwards where the owner was standing. The visual field, e.g. the area that is perceived by an eye when it is fixed on one point, in dogs varies by breed (Murphy and Pollock, 1993). So-called brachycephalic breeds (shorter nose, eyes more laterally placed) differ from mesocephalic breeds (longer nose, eyes more forward looking) in the extent of the visual field and the amount of binocular overlap. Nevertheless, in general the field of view in dogs is estimated to be 240°, in humans it is about 200° (Sherman and Wilson, 1975). As hypothesized, due to the larger visual field dogs might be able to perceive what the partner is doing without having a direct look at it.

6.3 Social relationship, sex

Social groups are characterized by established hierarchies that define an individualôs position within the group and serve to reduce conflicts among group members. The daily cohabitation of individuals is controlled by existing rank differences between them. Cafazzo et al. (2009) described a sex age-graded hierarchy model in a population of free-ranging dogs. They found that males dominate females in each age class (adults dominate subadults, subadults dominate juveniles), although there was more flexibility among juveniles, as some females dominated some males. Adult abandoned individuals or orphans were subordinate to subadult dogs. Aggression was correlated with higher age but not with gender and the highest levels of competition were observed in the presence of food. Dominants obtain for example privileged access to food, social and sexual partners. Thus, dominants, even in relatively socially tolerant species, are expected to be more upset when facing disadvantageous inequity related to an subordinate partner, as they are used to receive more (Brosnan, 2006). Reverse, the subordinates are expected to be more inured to inequitable situations, as they are accustomed to discrimination in their daily life.

In chimpanzees (Brosnan et al., 2010), it was found that subjectsôrank had an effect on the refusal rates with higher-ranking individuals refusing more often to exchange

in contrast to the lower-ranking partner. None of the more recent confirmed this effect of rank (Bräuer et al., 2006, Brosnan et al., 2004, Fontenot et al., 2006). In our study, we could neither detect any difference between dominants and subordinates and their willingness to give the paw. Contrary to the predictions, the dominant ones tend to be more persistent on average with higher total numbers of giving the paw. Brosnan et al. (2010) stated the possibility that this lack of effect of dominance rank can be ascribed to the originator of inequity. Since the experimenter and not the partner is responsible for the unequal distribution of food, reactions to inequity may be directed at the experimenter.

In feral dogs, it regularly appears that dominants steal food or displace subordinates from food and display aggressive behaviour in the presence of nutrition (Cafazzo et al., 2009). Pet dogs, in contrast, live with their owner in an interspecies pack where typically the human is assigned the part of the group leader. The owner on top is then followed by the first ranking dog and the second ranking dog is at the bottom of the hierarchy. Pet dogs are provided with food by their owners on a daily basis and according to the questionnaire, both dogs that participated in our study receive their food at the same time, not favouring the dominant by getting served first. Furthermore, as every individual gets its share it is not necessary to fight for it and it is likely to assume that potential aggression during feeding would be prohibited by the owner. Modified circumstances regarding food acquisition compared to feral dogs and the presence of the dogsôowner who is dominant over both dogs and might act as a constraint might explain why dominants and subordinates did not differ in their behaviour in the IA.

In humans, people in close relationships are more likely to possess a communal orientation than in distant ones (Clark and Grote, 2003), which means that individuals in close relationships show reduced sensitivity to inequality. Chimpanzees in the study of Brosnan et al. (2004) behaved differently dependent on the social stability of the group they belonged to. Individuals from pair-housed dyads or short-term social groups refused to exchange a token in iniquitous conditions but not the individuals from the long-term social group which barely refused to exchange. Based on these findings, we had a closer look at the number of years dogs already lived together and distinguished between short-term and long-term (more or less than 2 years) dyads.

Dogs from the long-term group may be considered to have a close relationship and should be more tolerant to inequity and keep on cooperating in the RI. No significant difference between the two groups compared to the RI of the IA could be found. Lacking a reference point after which amount of time a dog dyad can be considered as a long term social group, the 2 years marker, on which we made our classification, was chosen arbitrarily. Potentially, a dog dyad can be called well-established after a shorter time, as rank order normally is cleared at a very early point. Of course, this rank order might not be rigid and can change over time but this was not the case in the dogs used in this study. All owners declared that they never had problems with battles for dominance between the dogs. The point of time on which we made our partition may not be chosen appropriately, therefore did not tell anything about how well established or close dyads were and furthermore could not explain the results in the RI.

An additional parameter for social relationship was extracted from the questionnaire. Owners were asked if it happened that one dog displaced the second one, if it wanted to get access to a certain place. Dogs that do not displace the conspecific showed reduced sensitivity to inequity, significantly working longer in the inequity condition of the IA. Individuals that displace the conspecific are used that they can occupy the place they want, banishing the conspecific via agonistic behaviour or a simple approach that suffices that the other one leaves. As they are used to get what they want, these individuals may react upset if they face a situation that leaves them unrewarded when they expect to receive a gratification and subsequently cease cooperation with the experimenter.

Dogsôsex did not affect the results. No effects of sex were found in capuchins (van Wolkenten et al., 2007), tamarins (Neiworth et al., 2009) and the chimps first tested in the study from Brosnan et al. (2004). In a later study in chimps (Brosnan et al., 2010) the researchers showed that males were more likely to react to inequity than females. Interestingly, males reacted to violations of social expectations (partner receives a better reward) as females responded negatively to violations of individual expectations (subject is shown high-value reward but receives low-value reward).

6.4 Outlook

When investigating the impact of the dogsôrelationship, since this is still an important factor that deserves a more in-depth investigation, it is suggested to think about possible parameters which might best explain the dogsôbond. Factors like proximity and time spent together (e.g. portion of body contact, amount of playing together), behaviour when encountering unfamiliar dogs/intruders, aggression or competition may be worth to have a closer look at. Even though we tried to answer some of these questions via a questionnaire, we would recommend designing experimental tests for data collection for a more detailed insight. Additionally, questionnaires bear the risk of reflecting humansô opinions and not always the pure facts. Furthermore, since testing dogs has the advantage that it is possible to recruit much more individuals than in non-human primates, it would be interesting to test more individuals from different dyads. A suggestion would be to compare the results from male-female, male-male, female-female, and kin pairs and interpret them from a view of social structure, sex and social relationship.

Aversion to inequity is a prerequisite that cooperation can occur. Dogs, as members of a highly social species that cooperate with conspecifics as well as with humans, seem to have a sense of fairness and react to unequal treatment. Till now, little is known about the mechanisms underlying the responses of dogs as well as of non-human primates. Further research to find answers to this complex issue is needed. Comparative testing of other social canids (e.g. wolves) under similar conditions could contribute further information. Nevertheless, interpretation of the animalsô reactions to iniquitous situations has to be made with precaution, as different social structures and environments might account for variation between species.

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8. Appendix

Questionnaire

Confidential data

Name: ----------

Address: ----------

Tel.Nr.: ----------

Dog owner

Sex: ☐ female ☐ male

Age: _____

Dog 1

Name: _____

Breed: _____

Date of birth: _____

Sex: ☐ female ☐ male

neutered: ☐ yes ☐ no

weight: _____

tests: ☐ BgH A ☐ BgH 1 ☐ BgH 2

☐ Agility ☐ sonstiges: _____

in the household since: _____

participated in any other studies: ☐ yes ☐ no

if so, what kind of studies: _____

Dog 2

Name: _____

Breed: _____

Date of birth: _____

Sex: ☐ female ☐ male

neutered: ☐ yes ☐ no

weight: _____

tests: ☐ BgH A ☐ BgH 1 ☐ BgH 2

☐ Agility ☐ sonstiges: _____

in the household since: _____

participated in any other studies: ☐ yes ☐ no

if so, what kind of studies: _____

1. **In your opinion, which dog is higher in the hierarchy?**

   ☐ dog 1 ☐ dog 2

2. **How distinct would you classify this difference in dominance?**

   ☐ distinctive ☐ indifferent ☐ not very distinctive ☐ no difference

3. **Did your dogs ever have struggles caused by hierarchy problems?**

   ☐ yes ☐ no

4. **When feeding your dog, do you make sure that the dominant dog gets the food prior to the subordinate?**

   ☐ yes ☐ no

5. **When feeding the dogs, are the dishes placed side by side?**

   ☐ yes ☐ no

   if not, what is the distance between them: _____

6. **Is the dominant dog the one who welcomes you first when arriving at your home?**

   ☐ yes ☐ no ☐ different

7. **If you open the door to go outside with your dogs, is the dominant dog the one who is at the door first?**

   ☐ yes ☐ no ☐ different

8. **Do your dogs have separate places to lay/sleep which are accordingly defended by them?**

   ☐ yes ☐ no ☐ it is alternating

9. **Does it happen that the dominant expels the subordinate if he wants to get to a certain place?**

   ☐ yes ☐ no

10. **Conversely, does it occur that the dominant is also expelled from his place by the subordinate?**

    ☐ yes ☐ no

11. **Would you say that you can observe submissive behaviour most of all in the subordinate (i.e. laying on the back, muzzle licking, é)?**

    ☐ yes ☐ no

12. **Does it happen that one dog expels his conspecific if he seems to be neglected with tender loving care? If so, who expels whom?**

    ☐ dog 1 dog 2 ☐ dog 2 dog 1 ☐ different

13. Do your dogs often lie side by side and keep body contact?

☐ yes ☐ no

14. Who is the one seeking more physical contact to the other dog?

☐ dog 1 to dog 2 ☐ dog 2 to dog 1 ☐ different ☐ no body contact

15. Do the dogs prefer to play with each other or with you/family member?

dog 1 ☐ mainly with dog 2 ☐ mainly with me/family member ☐ indifferent

dog 2 ☐ mainly with dog 1 ☐ mainly with me/family member ☐ indifferent

16. Who is the one that normally invites the other dog to play?

☐ dog 1 dog 2 ☐ dog 2 dog 1 ☐ different

17. If the dogs are separated for a short period of time, who is the one that suffers more?

☐ dog 1 ☐ dog 2 ☐ no one suffers ☐ never separated

18. Does it happen that one dog growls at his conspecific? If so, who is the one that mainly starts?

☐ dog 1 ☐ dog 2 ☐ different ☐ no one growls

19. For which dog is it easier to learn a new task?

☐ dog 1 ☐ dog 2 ☐ different

20. Does it occur that one of your dogs behaves aggressive when getting in contact with an unfamiliar dog? If so, which one?

☐ dog 1 ☐ dog 2 ☐ different ☐ no oneôs aggressive

21. Are the dogs kept in steady contact with you/the family?

☐ yes, they are allowed to stay in the house all day and night
☐ no, they are kept in the garden/kennel over night

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